Check List the journal of biodiversity data

LISTS OF SPECIES

Check List 13(3): 2129, 28 May 2017 https://doi.org/10.15560/13.3.2129
ISSN 1809-127X © 2017 Check List and Authors

Medium-sized to large mammals of Serra do Tombador, Cerrado of Brazil

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Abstract: The Cerrado is the second largest biome of Brazil and one of the most threatened, mainly due to habitat conversion and agricultural expansion. At the same time, the fauna of the Cerrado is poorly known. In this study, undertaken from April to July of 2012, we provide a checklist of the medium-sized to large mammals recorded by camera traps in the Reserva Particular do Patrimônio Natural Serra do Tombador, a private protected area located in northern Goiás state. With a total effort of 2,340 camera-days, we recorded 17 species including rare and threatened species, among them jaguar (*Panthera onca*), giant armadillo (*Priodontes maximus*), tapir (*Tapirus terrestris*) and giant anteater (*Myrmecophaga tridactyla*). Our results suggest that the surveyed protected area has importance in the conservation of mammals in the Cerrado.

Key words. Carnivores; Felidae; private natural heritage reserve; Chapada dos Veadeiros

INTRODUCTION

The Cerrado is a diverse South American savannah comprising a mosaic of plant physiognomies, varying from open grassland to closed woodlands; it is vast, covering an area of around 2 million square kilometers in Brazil (Costa 2003, Johnson et al. 1999). However, it is a threatened biome and has been listed among the 34 world biodiversity hotspots (Mittermeieret al. 2005). The biodiversity of the Cerrado is suffering losses due to the high rate of habitat conversion imposed by expansion of the agricultural frontier (Grecchi et al. 2014). Habitat conversion now extends over more than 51% of the biome's area and conservation units protect only 6.2% of the remaining Cerrado biome (Beuchle et al. 2015). To date, the mammal richness of the Cerrado is reported to be between 227 (Carmignotto et al. 2012) and 251 species (Paglia et al. 2012). Twenty-two species are endemic (Gutiérrez & Marinho-Filho 2017).

Although inventories of mammals have already been carried out in several areas of the Cerrado, the mammalian fauna remains little-known and poorly documented. Most of the inventories have not been published (Britoet al. 2009, Carmignotto et al. 2012). Species occurrence data is fundamental information for scientific research and conservation. For many protected area of Cerrado, species composition data are not available. Species checklists are one approach to filling this knowledge gap.

In this study, we provide a list of the medium-sized to large mammals from Serra do Tombador Private Natural Heritage Reserve (PNHR). This reserve is situated in an area of priority for the conservation of Cerrado biome (MMA 2007), which reinforces the importance of our inventory.

MATERIALS AND METHODS

Study site

Serra do Tombador is located in the northeast of Goiás state, in Cavalcante county, between latitudes 13°35′ W and 13°43′ S and longitudes 047°44′ W and 047°53′ W. The Serra do Tombador PNHR covers 8730 ha of the Cerrado biome. Its vegetation comprises rocky fields, gallery forest, Cerrado *sensu stricto*, and forest savannah (Fig. 1).

According to the Köppen-Geiger classification, the climate in the reserve is Tropical Savannah with a dry season in the winter, characterized by hot and semihumid conditions. Average annual rainfall is 1580 mm, varying from 100 to 300 mm in rainy months (November to March) and not exceeding 100 mm in the dry months (June to August) (PM-RNST 2011). The temperature can change drastically in the study area, influenced by a topography that reaches altitudes of 1118 m. In warm months (September to October), the average temperature varies between 24 °C and 36 °C in the lowlands, but it is lower than 24 °C in the uplands. In cold months (June and July), the average temperature of lowlands varies between

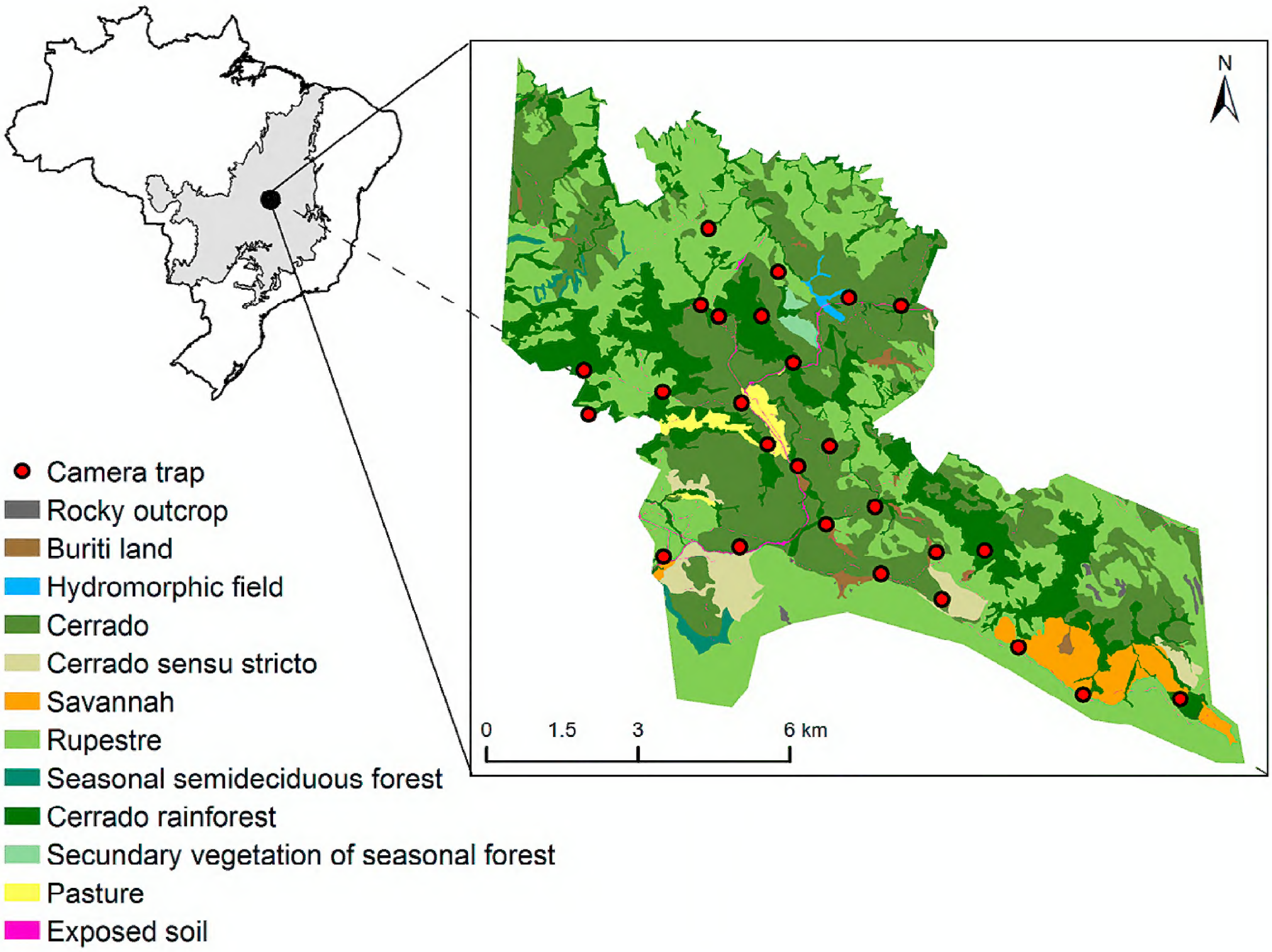

Figure 1. Study site location. At left, Brazilian territory and the Cerrado biome (grey), in which the Serra do Tombador Private Natural Heritage Reserve is marked (black circle). At right, limits of the study site, its vegetation types, and camera trap locations.

12 °C and 14 °C while in the uplands it varies between 8 °C and 10 °C (PM-RNST 2011).

Data collection

We used 26 Tigrinus® camera traps (15 analog and 11 digital) to carry out a mammal survey from April to July of 2012 (Fig. 1). The camera traps were installed 45 cm above the ground in various habitats, with inter-camera distances ranging from 400 to 1800 m. Camera traps were programmed to operate 24 hours per day, with an interval of 5 minutes between each record. This non-invasive tool has proven to be efficient under most field conditions, permitting detection and identification of even some cryptic mammal species (Srbek-Araujo & Chiarello 2005, Trolle & Kery 2005). We identified the photographed species to the lowest possible taxonomic level using Eisenberg & Redford (1999) and following the nomenclature proposed by Wilson & Reeder (2005). The geographic coordinates of camera traps were recorded using a GPS receiver. Camera trap sampling effort was determined according to Srbek-Araujo & Chiarello (2005) and estimated via species accumulation curves, following Colwell et al. (2012).

RESULTS

With a sampling effort of 2340 camera-days, we obtained 92 photographs of 14 native mammals identified to species belonging to 7 orders and 11 families (Fig. 2, Table 1). We could not identify to species two taxa : brocket deer of the genus *Mazama* and small spotted felids of the genus *Leopardus*. We could, however, accurately identify the medium-sized *Leopardus pardalis*, which is not part of the group of species (Fig. 2). With the two undetermined species (*Mazama* sp. and *Leopardus* sp.) included, the local species richness of medium-sized mammals was 16. According the species accumulation curves, the sampling effort was sufficient to characterize the medium-sized to large mammals of study area (Fig. 3).

Carnivora was the richest order with 7 species, followed by Rodentia with 2 species. The species with the highest numbers of records were *Myrmecophaga tridactyla* Linnaeus, 1758 (n = 23), and *Tapirus terrestris* Linnaeus, 1758 (n=21), while several species were only photographed once (Table 1; Fig. 4A). *Myrmecophaga tridactyla* was photographed at 7 of the 27 camera trap stations, *Chrysocyon brachyurus* (Illiger, 1815) at 6, and *T. terrestris* and *Mazama* sp. were both photographed at 5 camera trap stations (Fig. 4B).

Figure 2. Photographic records of mammal species recorded in Serra do Tombador Private Natural Heritage Reserve, Goiás, Brazil. (**A**) *Lycalopex vetulus*, (**B**) *Cerdocyon thous*, (**C**) *Chrysocyon brachyurus*, (**D**) *Leopardus pardalis*, (**E**) *Leopardus* sp., (**F**) *Panthera onca*, (**G**) *Puma concolor*, (**H**) *Eira barbara*, (**I**) *Nasua nasua*, (**J**) *Priodontes maximus*, (**K**) *Didelphis albiventris*, (**L**) *Cuniculus paca*, (**M**) *Dasyprocta azarae*, (**N**) *Tapirus terrestris*, (**O**) *Myrmecophaga tridactyla*, and (**P**) *Mazama* sp.

Table 1. Species list of medium-sized to large mammals recorded at Serra do Tombador Private Natural Heritage Reserve, Goiás, Brazil. Conservation status according to IUCN Red List (2016) and MMA, Brazil (2014). Status abbreviations: LC = Least Concern, NT = Near Threatened, VU = Vulnerable, and DD = Data Deficient.

Order	Family	Scientific name	Common name	IUCN	MMA
Artiodactyla	Cervidae	*Mazama* sp.	Deer	LC	LC
Carnivora	Canidae	*Cerdocyon thous* Linnaeus 1766	Crab-eating Fox	LC	LC
		Chrysocyon brachyurus (Illiger, 1815)	Maned Wolf	NT	VU
		Lycalopex vetulus (Lund, 1842)	Hoary Fox	LC	VU
	Felidae	*Leopardus pardalis* (Linnaeus, 1766)	Ocelot	LC	LC
		Leopardus sp.	—	—	—
		Panthera onca (Linnaeus, 1758)	Jaguar	NT	VU
		Puma concolor (Linnaeus, 1771)	Puma	LC	VU
	Mustelidae	*Eira barbara* (Linnaeus, 1758)	Tayra	LC	LC
	Procyonidae	*Nasua nasua* (Linnaeus, 1766)	South American Coati	LC	LC
Cingulata	Dasypodidae	*Priodontes maximus* (Kerr, 1792)	Giant Armadillo	VU	VU
Didelphimorphia	Didelphidae	*Didelphis albiventris* Lund, 1840	White-eared Opossum	LC	LC
Rodentia	Cuniculidae	*Cuniculus paca* (Linnaeus, 1766)	Lowland Paca	LC	LC
	Dasyproctidae	*Dasyprocta azarae* Lichtenstein, 1823	Azara's Agouti	DD	LC
Perissodactyla	Tapiridae	*Tapirus terrestris* Linnaeus, 1758	Brazilian Tapir	VU	VU
Pilosa	Myrmecophagidae	*Myrmecophaga tridactyla* Linnaeus, 1758	Giant Anteater	VU	VU

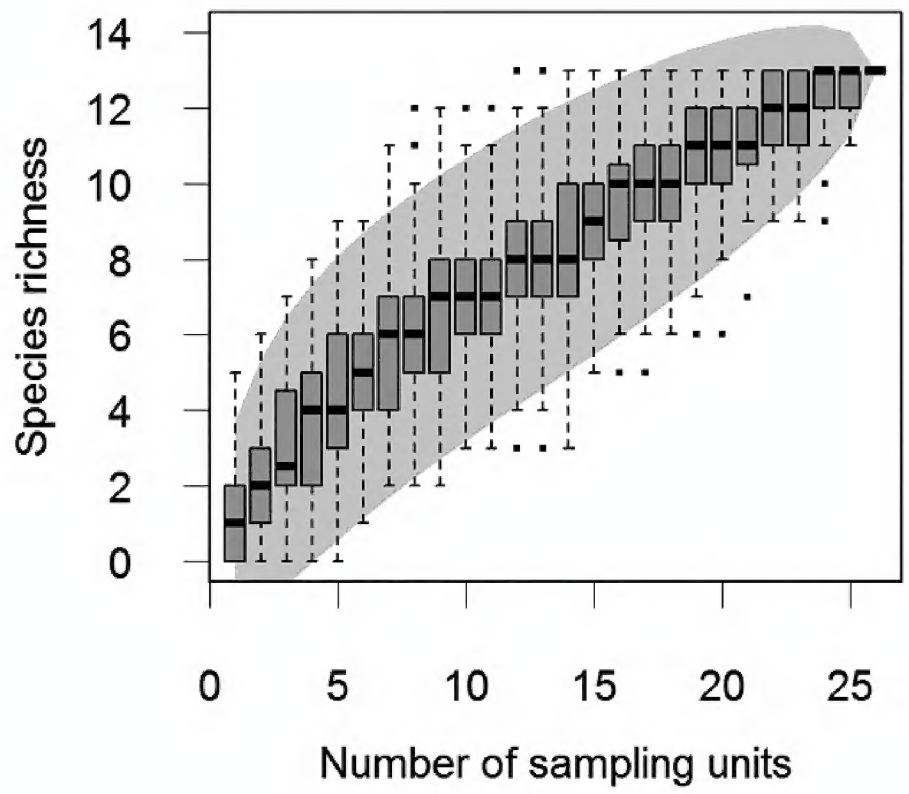

Figure 3. Species accumulation curves relating the number of species and sampled sites, showing the sampling sufficiency of camera trap method.

DISCUSSION

The species richness observed in our study ($n = 17$) represents around 7% of all mammal species recorded in the Cerrado biome (Carmignotto et al. 2012), but we focused on medium-sized to large mammals only. Studies carried out in different areas of the Cerrado biome have recorded diversities of medium-sized to large terrestrial mammal ranging from 10 to 39 species (Bocchiglieri et al. 2010, Gomes et al. 2015, Leite et al. 2016, Moreira et al. 2008, Schneider, 2000, Silveira et al. 2003; Trolle et al. 2007). Considering the greatest diversity yet reported ($n = 39$; Schneider 2000), our study detected around 40% of the medium-sized to large terrestrial mammals recorded in the Cerrado of Brazil. Compared with other studies, such as that of Silveira et al. (2003) in the grasslands of Emas National Park, we detected approximately 60% of species (17 out of 28 in that study). However, Emas National Park has an area 15 times larger than Serra do Tombador PNHR, so a greater species richness is expected there.

Carnivora was the richest order in our study. This pattern has been observed in other mammal studies carried out in the Cerrado (Bocchiglieri et al. 2010, Bruna et al. 2010, Santos et al. 2016, Trolle et al. 2007). Nevertheless, *Conepatus semistriatus* Boddaert, 1785, which is a typical Cerrado carnivore, was not recorded. Among the 9 carnivores detected by our camera traps, 3 are threatened in Brazil according to MMA (2014): *Chrysocyon brachyurus, Panthera onca* (Linnaeus, 1758), and *Puma concolor* (Linnaeus, 1771), of which we obtained few records. Carnivores, especially the felids, generally occur at low densities and require large areas (Cheida et al. 2011). Even considering the rarity of these species, the photographic rates of some carnivores were lower than expected in a protected area, which could be an indicative of declining population, as suggested by global and national trends (Table 1). This might be related to anthropogenic pressures in the surroundings of Serra do Tombador PNHR, evidenced mainly by habitat fragmentation and conversion to agriculture.

Rodentia was the second most species rich order, even though we only recorded 2 species. Rodent richness was certainly under represented, given that it is the second richest mammalian order in the Cerrado (with approximately 78 species), second only to Chiroptera (Carmignotto et al. 2012). Both species of rodents in our study are those usually detected in surveys of medium-sized to large terrestrial mammal surveys (Trolle et al. 2006, Gomes et al. 2015, Leite et al. 2016). Under representation of small rodents in our study relates to the lower capture probability of these animals by camera traps because they can pass in front of cameras without triggering them (Tobler et al. 2008). Therefore, to generate a more complete list of mammal species, it will be necessary to use complementary methods such as those employed by Gomes et al. (2015) at Serra do Facão (central Brazil), who detected 63 species of mammals, of which 12 were small rodents captured

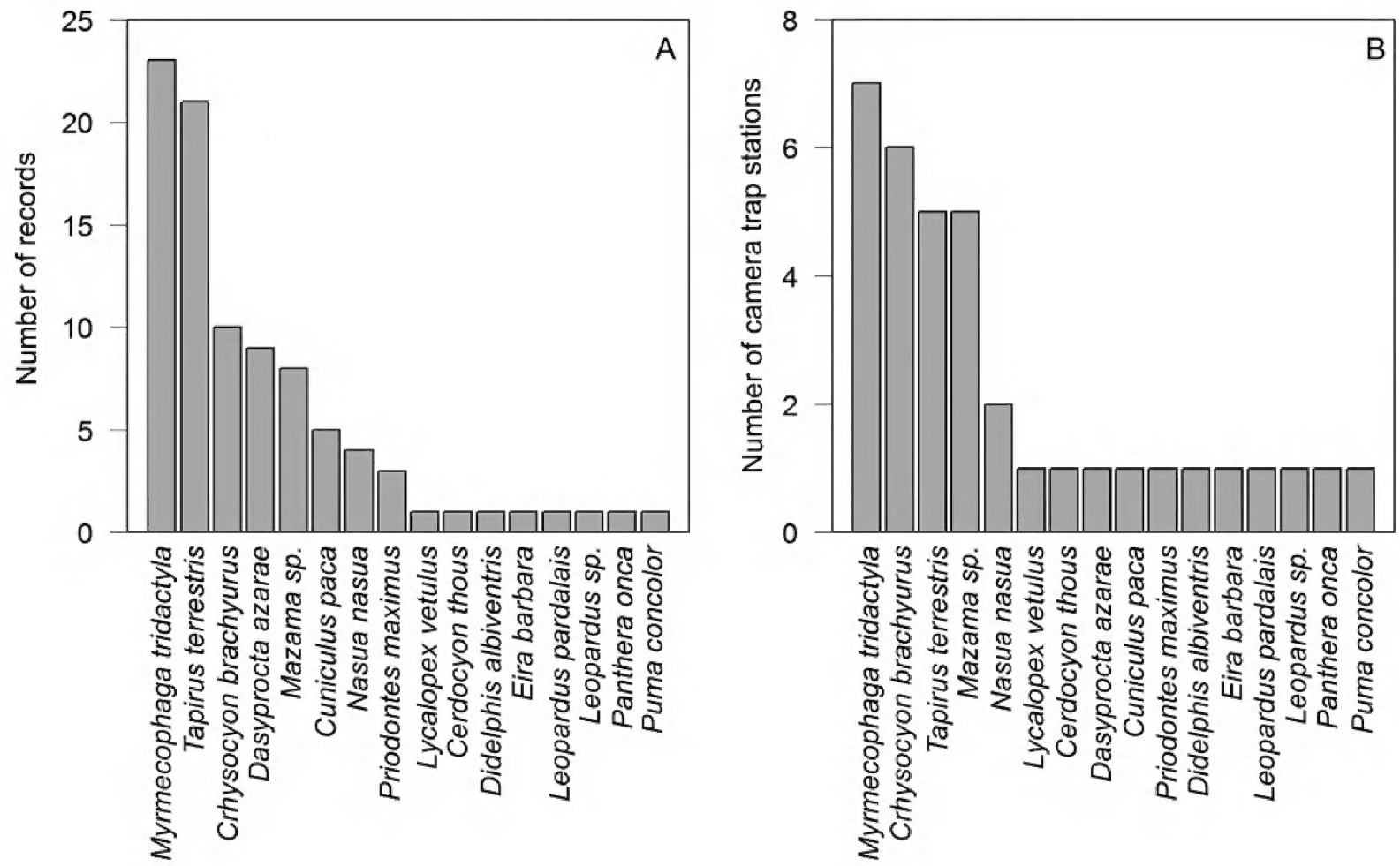

Figure 4. Number of records (**A**) and camera trap stations (**B**) for each of the large and medium sized mammals registered in the Serra do Tombador Private Natural Heritage Reserve, Goiás, Brazil.

with Sherman and Tomahawk traps.

Half of the species that we detected are threatened at either globally or nationally, which shows the importance of Serra do Tombador PNHR to biodiversity. We detected a species categorized as Data Deficient by the IUCN (2016), *Dasyprocta azarae* Lichtenstein, 1823 (Trindade-Filho et al. 2012).

We also recorded the *Priodontes maximus* (Kerr, 1792), which is poorly known (Porfirio et al. 2012) and globally Threatened (IUCN 2016). Conversely, we did not detect common species of armadillos such as *Euphractus sexcinctus* (Linnaeus, 1758) and *Dasypus novemcinctus* Linnaeus, 1758. These absences may be related to subsistence hunting, which still threatens Serra do Tombador PNHR, despite systematic patrols conducted by managers (Marcello Borges, pers. comm.).

Although Serra do Tombador PNHR is under strong anthropogenic pressure, it maintains species with high ecological requirements, such as jaguars, pumas, giant armadillos, and tapirs. The occurrence of these large-bodied species suggests that the reserve has some degree of environmental suitability and, with adequate population management, these populations should persist in the long term. Nearby areas, such as the Chapada dos Veadeiros National Park (65,500 ha) that is 30 km away, are certainly an important refuge and source for local carnivore populations. Maintenance of carnivore populations in the region is important because they regulate ecosystem functions; for example, large felids control herbivores and mesopredators, and tapirs are vital seed dispersers (Campos et al. 2012).

Because mammal inventories are still incomplete for the Cerrado (Carmignotto et al. 2012), our study fills part of this knowledge gap and provides information useful for management plans of the Serra do Tombador PNHR, given its proximity to Chapada dos Veadeiros National Park. The development of management plans for this area is crucial, especially for the jaguars, pumas, tapirs, and giant armadillos due to their ecological requirements. We highlight the importance of private protected areas such as Serra do Tombador PNHR, particularly because government initiatives are insufficient to guarantee biodiversity in the Cerrado biome.

ACKNOWLEDGEMENTS

We thank Daniele Gidsicki, Marcello Borges, and Gilson Araujo Berberino for logistical support during the fieldwork. This research was supported by Fundação O Boticário de Proteção à Natureza (Project 0928_20112). RC was supported by a Capes M.Sc. fellowship. MZ is currently supported by a CNPq DCR fellowship (312627/2015-7). GP is currently supported by a Capes PNPD fellowship (20132885). DB is supported by a CNPq Research Productivity Fellowship.

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Authors' contributions. RC, MZ, and GP collected the data, RC identified the species, MZ made the analysis and figures, and RC, MZ, GP, and DB wrote the text.

Received: 13 December 2016
Accepted: 14 April 2017
Academic editor: Guilherme S. T. Garbino